Sandia National Laboratories

Numerical Simulation of Wire Array Implosions

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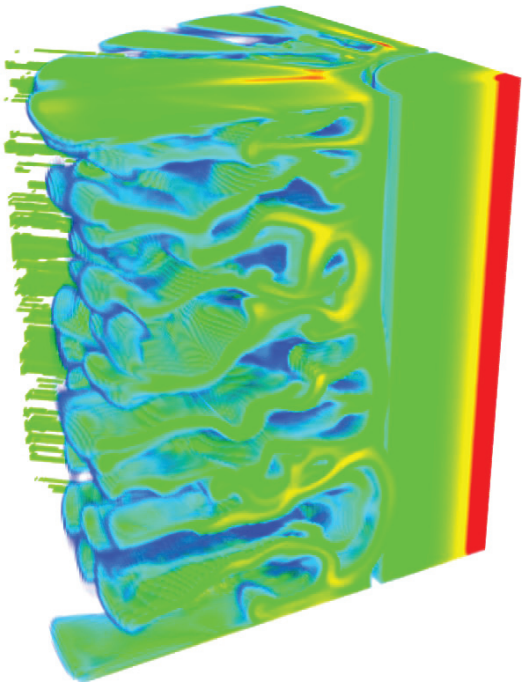
Project Description

Sandia implodes cylindrical arrays of wires on the pulsed power Z-machine to produce radiation for inertial confinement fusion (ICF) and other related experiments. The individual wires are quickly heated (exploded) by electrical energy and form an unstable plasma liner that is driven to collision on axis at very high velocity. Sandia Advanced Simulation & Computing (ASC) has a magnetized High Energy Density Physics (HEDP) modeling program to design and understand wire array physics, but these problems are inherently 3-D and extremely challenging. In many cases, the physics is unknown, and modeling is used as an exploration tool to understand what is missing. In particular, the physics of wire initiation and ablation into a plasma shell is not well understood.

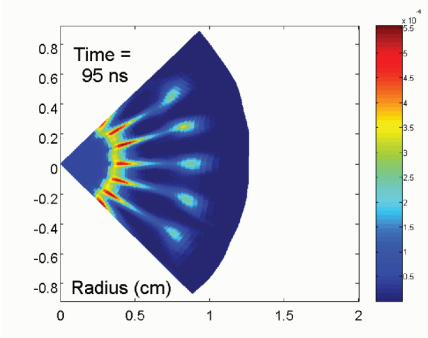
VNIITF also has a sophisticated magnetized HEDP modeling program and works with experimentalists at High Current Electronics Institute (HCEI, Tomsk), VNIIEF (S-300 at Sarov), and TRINITI (Angara V at Moscow), as well as with Sandia and Imperial College, London, England. In particular, VNIITF is making progress incorporating kinetic effects in HEDP simulations through hybrid models performing high-order Eulerian adaptive mesh simulations, whereas Sandia's efforts are in Lagrangian ALE codes. As part of this contract, VNIITF will use its codes to simulate wire array implosion phenomena.

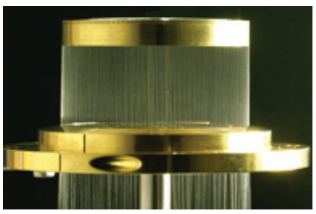
Five tasks will be performed at the discretion of the Sandia principal investigator:

- Develop a modeling plan: physics, algorithms, numerical methods;
- Perform simulations using an existing MHD code, refining the code as necessary to capture specific physics of wire explosions and wire array compression;
- Perform verification and validation tests, including comparison of material models and comparison with Sandia codes;
- Add advanced MHD terms to the code;
- Implement adaptive gridding.



Simulations using 3-D radiation-MHD capability in ALEGRA-HEDP provide understanding to scale to ZR.





40mm diameter array of 240, 7.5 - µm-diameter wires.

Technical Purpose and Benefits

The governing factor for this collaboration is the need to explore the impact of a variety of physics and modeling choices on wire array physics to verify and validate modeling choices used for experiment and machine design. Neither Sandia nor VNIITF has a complete understanding of wire array physics, yet each has areas of complementary expertise. The benefit of this collaboration will be an increased understanding of wire array physics, and specifically a greater understanding of the validity of modeling choices.

Collaboration between Sandia National Laboratories (SNL), Albuquerque, NM, USA, and the Russian Federal Nuclear Center – All Russian Research Institute of Technical Physics (RFNC-VNIITF), Snezhinsk, Russia

A Publication of the Office of Advanced Simulation & Computing, NNSA Defense Programs. SAND 2007-4400P
Issued by Sandia National Laboratories for NNSA's Office of Advanced Simulation & Computing, NA-114. Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.